

**ABSTRACT**

An oxygen enriched boiler having a burner subassembly and a steam subassembly is disclosed. The burner subassembly has a fuel inlet, an oxidant inlet, a combustion chamber, a flue gas composition detector and a flue gas outlet. The fuel inlet provides fuel to the combustion chamber, the oxidant inlet provides an oxygen-enriched inlet stream to the combustion chamber, the combustion chamber burns the fuel and the flue gas composition detector measures at least one characteristic of the flue gas. The steam subassembly has a supply water inlet, a heat exchange zone, a water drum, a steam quality actuator and a steam outlet. The supply water inlet provides feed water to the heat exchange zone, the heat exchange zone transfers heat generated by combustion of the fuel to the water to generate steam, the water drum receives the heated water and steam from the heat transfer zone and maintains the water and steam at a selected steam pressure and water level, and the steam quality actuator regulates at least one characteristic of the steam. Flue gas characteristics, as well as other boiler performance variables, are monitored. At least one controller actuates on the oxidant injections to control combustion. The controller calculates the optimum oxidant distribution in real-time for a series of injection points to minimize undesired flue gas emissions while maintaining the desired steam conditions and boiler operating conditions.